CLAIMS:

1. An aerosol time-of-flight mass spectrometer comprising:

an elongated sealed vacuum chamber having an axial direction with a central longitudinal axis, said elongated sealed vacuum chamber having an input side and an opposite side, said input side having at least two inlet ports for admission to said elongated sealed high-vacuum chamber of at least two flows of charged particles of a substance to fly through said elongated sealed vacuum chamber simultaneously and independently of each other;

electrostatic field generation means for generating an electrostatic field in said an elongated sealed vacuum chamber for causing charged particles that entered said elongated sealed high-vacuum chamber through said at least two inlet ports to fly along different curvilinear trajectories in a direct path from said input side towards said opposite side and in a return path from said opposite side to said input side; and

a charged particle detector means for detecting positions of collisions of said charged particles with said charged particle detector means for determining the time of flight of said charged particles independently for each of said at least two flows, said charged particle detector means being located in the vicinity of said at least two inlet ports and generating collision signals at the moments of said collisions.

2. The aerosol time-of-flight mass spectrometer according to Claim 1, wherein said electrostatic field generation means comprise:

a plurality of quadrupole electrostatic lenses which are arranged in series and coaxially in said direction from said input side to said opposite side, each of said quadrupole electrostatic lenses comprising a circular body formed by four arch-shaped poles located substantially in a common plane perpendicular to said central longitudinal axis and arranged circumferentially about said central longitudinal axis in the form of a first pair composed of two diametrically opposite and electrically

connected poles and a second pair composed of two diametrically opposite and electrically connected poles, in each of said quadrupole electrostatic lenses said poles being angularly shifted with respect to said poles of a quadrupole electrostatic lens subsequent in said direct path by a selected angle in order to provide said angular gradient of the electrostatic field between adjacent quadrupole lenses of said plurality and thus to cause said charged particles to move along said curvilinear trajectories; and

mirror means comprising: an electrostatic mirror located on said opposite side for reflecting said charged particles in a return direction opposite to said direction from said input side to said opposite side for dividing said helical trajectories into a direct section for movement of said charged particles in said direction from said input side to said opposite side and a return section for movement of said charged particles in a direction from said opposite side to said input side.

3. The aerosol time-of-flight mass spectrometer according to Claim 1, further comprising charged-particle deflection means located in front of said at least two inlet ports in the direction from said input side to said opposite side, said charged-particle deflection means comprising: a flow deflection unit for dividing in an alternating mode a single flow of charged particles received by said charged-particle deflection means into said at least two flows of charged particles; a steering unit for correcting trajectories of said at least two flows of charged particles for directing them to said at least two inlet ports; and random pulse modulation means connected to said charged-particle deflection means for generating irregular sequence of said charged particles in said at least two flows.

4. The aerosol time-of-flight mass spectrometer according to Claim 2, further comprising charged-particle deflection means located in front of said at least two inlet ports in the direction from said input side to said opposite side, said charged-particle deflection means comprising: a flow deflection unit for dividing in an alternating mode a single flow of charged particles received by said charged-particle

deflection means into said at least two flows of charged particles; a steering unit for correcting trajectories of said at least two flows of charged particles for directing them to said at least two inlet ports; and random pulse modulation means connected to said charged-particle deflection means for generating irregular sequence of said charged particles in said at least two flows.

5. The aerosol time-of-flight mass spectrometer according to Claim 1, wherein said flow deflection unit comprises a first electrode plate and a second electrode plate spaced from said first electrode plate, said first electrode plate being connected to a first power supply that provides deflection of said single flow of charged particles by an angle α towards one of said at least two inlet ports, said second electrode plate being connected to a second power supply via a switching unit that provides deflection of said single flow of charged particles by an angle 2α towards another of said at least two inlet ports.

6. The aerosol time-of-flight mass spectrometer according to Claim 5, wherein said steering unit comprises a third electrode plate connected to a source of a permanent potential, a fourth electrode plate connected to a source of a permanent potential, and a fifth grounded electrode located between said third electrode and said fourth electrode, one of said at least two flows of charged particles being directed to one of said at least two inlet ports via a space between said third plate electrode and said fifth grounded electrode, while another of said at least two flows of charged particles being directed to another of said at least two inlet ports via a space between said fourth plate electrode and said fifth grounded electrode.

7. The aerosol time-of-flight mass spectrometer according to Claim 4, wherein said flow deflection unit comprises a first electrode plate and a second electrode plate spaced from said first electrode plate, said first electrode plate being connected to a first power supply that provides deflection of said single flow of charged particles by an angle α towards one of said at least two inlet ports, said second electrode plate

being connected to a second power supply via a switching unit that provides deflection of said single flow of charged particles by an angle 2α towards another of said at least two inlet ports.

8. The aerosol time-of-flight mass spectrometer according to Claim 7, wherein said steering unit comprises a third electrode plate connected to a source of a permanent potential, a fourth electrode plate connected to a source of a permanent potential, and a fifth grounded electrode located between said third electrode and said fourth electrode, one of said at least two flows of charged particles being directed to one of said at least two inlet ports via a space between said third plate electrode and said fifth grounded electrode, while another of said at least two flows of charged particles being directed to another of said at least two inlet ports via a space between said fourth plate electrode and said fifth grounded electrode.

9. The aerosol time-of-flight mass spectrometer according to Claim 2, wherein said selected angle is equal to 360° divided by the number of quadrupole electrostatic lenses in said plurality.

10. The aerosol time-of-flight mass spectrometer according to Claim 9, wherein said curvilinear trajectories are helical trajectories.

11. The aerosol time-of-flight mass spectrometer according to Claim 2, further comprising: a first power source having a negative terminal, a positive terminal, and a midpoint between said negative terminal and said positive terminal; and a second power source having a negative terminal and a positive terminal; said first pair of two diametrically opposite poles being connected to said positive terminal of said first power source via a first resistor, said second pair of two diametrically opposite poles being connected to said negative terminal of said first power source, said midpoint of said first power source being connected to said negative terminal of said second power source via a second resistor, said positive terminal of said second power

source being grounded, said second power source generating a current of a high voltage which is higher than voltage of said first power source; said high voltage decreasing from one quadrupole electrostatic lenses to another quadrupole electrostatic lenses in said direct path.

12. The aerosol time-of-flight mass spectrometer according to Claim 10, further comprising: a first power source having a negative terminal, a positive terminal, and a midpoint between said negative terminal and said positive terminal; and a second power source having a negative terminal and a positive terminal; said first pair of two diametrically opposite poles being connected to said positive terminal of said first power source via a first resistor, said second pair of two diametrically opposite poles being connected to said negative terminal of said first power source, said midpoint of said first power source being connected to said negative terminal of said second power source via a second resistor, said positive terminal of said second power source being grounded, said second power source generating a current of a high voltage which is higher than voltage of said first power source; said high voltage decreasing from one quadrupole electrostatic lenses to another quadrupole electrostatic lenses in said direct path.

13. The aerosol time-of-flight mass spectrometer according to Claim 7, further comprising: a first power source having a negative terminal, a positive terminal, and a midpoint between said negative terminal and said positive terminal; and a second power source having a negative terminal and a positive terminal; said first pair of two diametrically opposite poles being connected to said positive terminal of said first power source via a first resistor, said second pair of two diametrically opposite poles being connected to said negative terminal of said first power source, said midpoint of said first power source being connected to said negative terminal of said second power source via a second resistor, said positive terminal of said second power source being grounded, said second power source generating a current of a high voltage which is higher than voltage of said first power source; said high voltage

decreasing from one quadrupole electrostatic lenses to another quadrupole electrostatic lenses in said direct path.

14. The aerosol time-of-flight mass spectrometer according to Claim 1, wherein said charged particle detector means comprise a first micro-channel plate detector which is aligned with one of said at least two inlet ports and a second micro-channel plate detector which is aligned with another of said at least two inlet ports, said first micro-channel plate detector having an opening aligned with said one of said two inlet ports for passing one of said at least two charged particles flows into said elongated sealed high-vacuum chamber, and said second micro-channel plate detector having an opening aligned with the other of said two inlet ports for passing the other of said at least two charged particles flows into said elongated sealed high-vacuum chamber.

14. The aerosol time-of-flight mass spectrometer according to Claim 2, wherein said charged particle detector means comprise a first micro-channel plate detector which is aligned with one of said at least two inlet ports and a second micro-channel plate detector which is aligned with another of said at least two inlet ports, said first micro-channel plate detector having an opening aligned with said one of said two inlet ports for passing one of said at least two charged particles flows into said elongated sealed high-vacuum chamber, and said second micro-channel plate detector having an opening aligned with the other of said two inlet ports for passing the other of said at least two charged particles flows into said elongated sealed high-vacuum chamber.

16. The aerosol time-of-flight mass spectrometer according to Claim 13, wherein said charged particle detector means comprise a first micro-channel plate detector which is aligned with one of said at least two inlet ports and a second micro-channel plate detector which is aligned with another of said at least two inlet ports, said first micro-channel plate detector having an opening aligned with said one of said two

inlet ports for passing one of said at least two charged particles flows into said elongated sealed high-vacuum chamber, and said second micro-channel plate detector having an opening aligned with the other of said two inlet ports for passing the other of said at least two charged particles flows into said elongated sealed high-vacuum chamber.

17. The aerosol time-of-flight mass spectrometer according to Claim 2, wherein said electrostatic mirror means comprise at least one electrostatic mirror coaxial with said quadrupole electrostatic lenses and located after the last quadrupole electrostatic lens in said charged particle propagation direction.

18. The aerosol time-of-flight mass spectrometer of Claim 17, wherein said at least one electrostatic mirror comprises a continuous ring with a positive potential applied from a power source, said at least one electrostatic mirror being provided with a potential adjustment means.

19. The aerosol time-of-flight mass spectrometer according to Claim 12, wherein said electrostatic mirror means comprise at least one electrostatic mirror coaxial with said quadrupole electrostatic lenses and located after the last quadrupole electrostatic lens in said charged particle propagation direction.

20. The aerosol time-of-flight mass spectrometer of Claim 19, wherein said at least one electrostatic mirror comprises a continuous ring with a positive potential applied from a power source, said at least one electrostatic mirror being provided with a potential adjustment means.

21. The aerosol time-of-flight mass spectrometer according to Claim 15, wherein said electrostatic mirror means comprise at least one electrostatic mirror coaxial with said quadrupole electrostatic lenses and located after the last quadrupole electrostatic lens in said charged particle propagation direction.

22. The aerosol time-of-flight mass spectrometer of Claim 21, wherein said at least one electrostatic mirror comprises a continuous ring with a positive potential applied from a power source, said at least one electrostatic mirror being provided with a potential adjustment means.

23. The aerosol time-of-flight mass spectrometer according to Claim 14, wherein said electrostatic mirror means comprise at least one electrostatic mirror coaxial with said quadrupole electrostatic lenses and located after the last quadrupole electrostatic lens in said charged particle propagation direction.

24. The aerosol time-of-flight mass spectrometer of Claim 23, wherein said at least one electrostatic mirror comprises a continuous ring with a positive potential applied from a power source, said at least one electrostatic mirror being provided with a potential adjustment means.

25. The aerosol time-of-flight mass spectrometer of Claim 2, further provided with a data acquisition and processing unit having means for analysis of mass distribution of said charged particles on the basis of said collision signals, said means for analysis having two independent processing channels for processing collision signals obtained independently for charged particles of each of said at least two flows, a correlator means for deconvolution of said collision signals for establishing a non-overlapping trains of deconvoluted signals, and means for increasing a duty cycle of said aerosol time-of-flight mass spectrometer due to overlapping of said deconvoluted signals in said two independent processing channels.

26. The aerosol time-of-flight mass spectrometer of Claim 14, further provided with a data acquisition and processing unit having means for analysis of mass distribution of said charged particles on the basis of said collision signals, said means for analysis having two independent processing channels for processing collision

signals obtained independently from said first micro-channel plate detector and from said second micro-channel plate detector, a correlator means for deconvolution of said collision signals for establishing a non-overlapping trains of deconvoluted signals, and means for increasing a duty cycle of said aerosol time-of-flight mass spectrometer due to overlapping of said deconvoluted signals in said two independent processing channels.

27. The aerosol time-of-flight mass spectrometer of Claim 15, further provided with a data acquisition and processing unit having means for analysis of mass distribution of said charged particles on the basis of said collision signals, said means for analysis having two independent processing channels for processing collision signals obtained independently from said first micro-channel plate detector and from said second micro-channel plate detector, correlator means for deconvolution of said collision signals for establishing a non-overlapping trains of deconvoluted signals, and means for increasing a duty cycle of said aerosol time-of-flight mass spectrometer due to overlapping of said deconvoluted signals in said two independent processing channels.

28. A method of mass spectrometry with the use of an aerosol time-of-flight mass spectrometer that receives a flow of charged particles for analysis, said mass spectrometer having an input side and an opposite side opposite to said input side, particle collision detection means on said input side, and data acquisition and processing means, said method comprising the steps of:

dividing said flow of charged particles into at least two flows of charged particles;

subjecting said charged particles in said at least two flows to random pulse modulation for generating irregular sequence of said charged particles in said at least two flows;

generating an electrostatic magnetic field in said mass spectrometer for directing said charged particles of said at least two flows along at least two

predetermined non-linear trajectories in a direct path from said input side to said opposite side and reflecting said charged particles in a return path from said opposite side to said input side;

detecting points of collision of said charged particles with said particle collision detection means independently for particles of each of said at last two flows;

generating and measuring collision detection signals that result from said collision independently for charged particles of each of said at least two flows and analyzing mass distribution of said charged particles of each of said at least two flows on the basis of said collision detection signals.

29. The method of Claim 28, further comprising the steps of :

deconvoluting said collision detection signals for establishing a non-overlapping trains of deconvoluted signals, and increasing a duty cycle of said aerosol mass spectrometer by overlapping said deconvoluted signals that correspond to said at least two flows.